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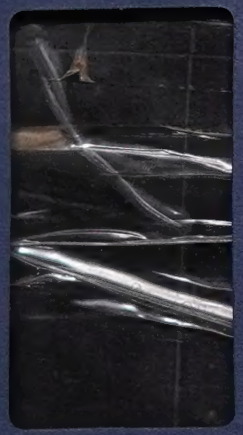
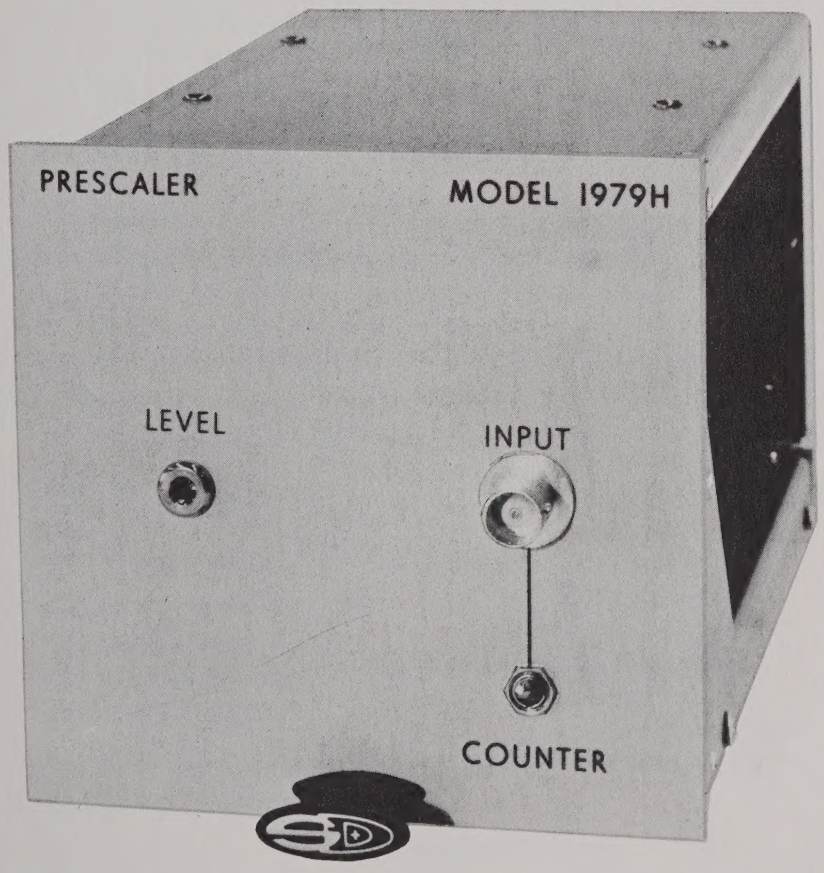


SD 1979H
350 MHz PRESCALER



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SD 1979H

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SD 1979H TABLE OF CONTENTS

		Page Number
CHAPTER 1	GENERAL INFORMATION	
1.1	General Description	1
1.2	Specifications	1
1.3	Equipment Supplied	1
1.4	Equipment Required but Not Supplied	1
1.5	Preparation for Reshipment	1
CHAPTER 2	INSTALLATION	
2.1	Installation Requirements	2
2.2	Inspection and Adjustment	2
2.3	Installation in Parent Counter	2
CHAPTER 3	OPERATION	
3.1	Functional Operation	2
3.2	Preparation For Use	3
3.3	Description of Controls	3
3.4	Sequence of Operation	3
3.5	Adjustment of Level Control	3
3.6	Operator's Maintenance	3
CHAPTER 4	TROUBLESHOOTING	
4.1	Overall Functional Description	4
4.2	Overall Troubleshooting	4
4.3	Time Base Divider Assembly, S23718	5
4.4	Prescaler Assembly, S23770	7
CHAPTER 5	MAINTENANCE	
5.1	Factory Service	11
5.2	Preventive Maintenance	11
5.3	Parts Replacement	11
5.4	Calibration	15
CHAPTER 6	PARTS LIST	

LIST OF ILLUSTRATIONS

FIGURES

1-1	Basic Block Diagram – Model 1979H Prescaler	1
3-1	Relationship of the SD 1979H to its Parent Counter	2
4-1	Functional Block Diagram – SD 1979H Prescaler Plug-In	4
4-2	Servicing Block Diagram – Time Base Divider	5
4-3	Servicing Block Diagram – Prescaler Assembly	6
4-4	Input Limiter	7
4-5	Amplifier-Shaper – Simplified Schematic	7
4-6A	Equivalent Circuit – Amplifier Shaper 1st Stage	8
4-6B	V-1 Characteristic, CR5	8

4-7 First Binary Circuit – Prescaler Assembly 9
4-8 Prescaler Waveforms – 100 MHz Input 10
5-1 Time Base PC Assembly, S23718 11
5-2 Schematic Diagram Time Base Divider, S23719 12
5-3 Prescaler Assembly, S23771 13
5-4 Prescaler Schematic, S23772 14
5-5 Tunnel Diode Test Circuit 15
5-6 Detail – Inductors L5, L6, L8, L9, L11, L12 15

TABLES

1-1 Equipment Supplied 1
1-2 Equipment Required but Not Supplied 1
3-1 Sequence of Operation 3
3-2 Level Adjustment 3
4-1 Overall Troubleshooting Procedure 4
4-2 Equipment Required for Troubleshooting 5
4-3 Time Base Divider Troubleshooting Procedure 5
4-4 Transistor DC Voltage Levels 7
4-5 Troubleshooting Procedure – Prescaler Assembly 10
4-6 Transistor DC Voltage Levels to Ground Prescaler Assembly 10
5-1 Parts Location – Time Base ÷ 8 PC BD. Assembly, S23718 13
5-2 Parts Location – Prescaler PC BD. Assembly, 23771 15
6-1 Parts List 17

CHAPTER 1
GENERAL DESCRIPTION

1.1 GENERAL DESCRIPTION

The SD 1979H Prescaler Plug-in extends the digital frequency measuring capability of the SD Models 1017, 1018, 1037 and 1038 counter-timers to 350 MHz. Operation is essentially automatic and is based on the technique illustrated in the block diagram of Figure 1-1.

The input signal is amplified and scaled by a factor of 8 to bring it within the direct measuring range of the counter. At the same time the counter time base is extended by the same factor resulting in a direct readout of the input signal frequency.

Input cables may be connected simultaneously to the 1979H input and the Counter's "C" input. The two-position toggle switch on the front of the 1979H determines which input is activated. In the COUNTER position, counter operation is normal.

1.2 SPECIFICATIONS

a. Frequency input range ..... DC to 350 MHz
b. Frequency output to counter ..... 1/8th of input
c. Accuracy ..... Same as parent counter
d. Input sensitivity ..... 100 mV rms
e. Maximum input level ..... 2 V rms
f. Input impedance ..... 50Ω(dc-coupled)
g. Operating temperature range ..... -20° C to +55° C
h. Double pulse resolution ..... 2.8 ns

1.3 EQUIPMENT SUPPLIED

Equipment and publications normally supplied are listed in Table 1-1.

QTY PER EQUIP	NAME	MODEL NO.	WEIGHT (lbs)
1	350 MHz Prescaler Plug-in	SD 1979H	3 (1.4 kg) 7 (3.2 kg) *
2	Instruction Manual		
1	Coaxial cable, 6-foot	SD 10338	
			*Shipping

Table 1-1 Equipment Supplied

1.4 RECOMMENDED EQUIPMENT FOR OPERATION & TEST

A list of equipment and publications required but not supplied for the operation, troubleshooting, and calibration of the SD 1979H is given in Table 1-2.

QTY PER EQUIP	NAME	MODEL NO.	REQUIRED USE
1	Electronic counter	SD 1017, 1018 1037 or 1038	Provide operating voltages and display
1	Instruction manual for counter		Provide operating instructions for counter
1	Volt-ohm-milliampmeter	Simpson 269 or equivalent	Troubleshooting
1	Oscilloscope	Tektronix 581 with 82 plug-in or equivalent	Troubleshooting and calibration
1	Sampling Oscilloscope	Tektronix 561A with sampling plug-ins	Troubleshooting and calibration
1	Signal Generator	HP model 608C or equivalent	Troubleshooting and calibration
1	Plug-in extender cable	SD 17245	Operation of plug-in outside of counter
1	DC Differential Voltmeter	Fluke type 801	Calibration

Table 1-2 Equipment Required but not Supplied

1.5 PREPARATION FOR RESHIPMENT

Should reshipment become necessary, contact the nearest Systron-Donner field office for shipping instructions. If possible, use the original packaging materials. Systron-Donner field offices can provide materials similiar to those used for original factory packaging. All correspondence should refer to the full nomenclature and serial number of the instrument involved.

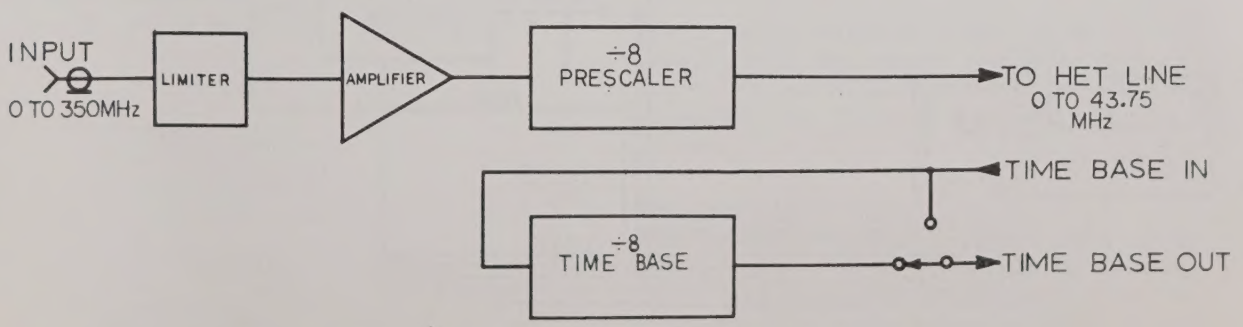

Figure 1-1 Basic Block Diagram – Model 1979H Prescaler

CHAPTER 2
INSTALLATION

2.1 INSTALLATION REQUIREMENTS

The SD 1979H is designed for use only with SD Models 1017, 1018, 1037 and 1038 counter-timers. Do not attempt to operate with any other model.

2.2 INSPECTION AND ADJUSTMENT

As soon as the instrument is received, verify that it is intact as ordered. Check for loose or broken control knobs, bent or broken connectors, and dents or scratches on the panel surfaces. If damage of any nature is found, refer to the Warranty (inside back cover) and to Paragraph 1.5 for repackaging and shipping instructions.

An overall functional test should be performed as soon as the instrument is received, following a procedure similiar to that given in Chapter 4 of this manual. Should the instrument fail to function properly or fail to meet specifications, contact your Systron-Donner Representative.

2.3 INSTALLATION IN PARENT COUNTER

To install the SD 1979H in the 1017, 1018, 1037 or 1038 counter-timer:

a. Make sure the counter's POWER switch is OFF.
b. Remove the plug-in or blank panel installed in the counter by turning the locking knob located at the left of the plug-in receptacle at least two turns counter-clockwise. Pull the plug-in out by its handle. Generally, a firm pull is required to unseat the connector.
c. Check to see that the printed-circuit boards in the 1979H are firmly seated, then insert the plug-in into the receptacle pushing it until it is flush with the counter's front panel. A firm push is usually necessary to properly seat the connector at the rear of the plug-in.
d. Lock the plug-in in place by turning the locking knob clockwise until tight. Check by giving the plug-in handle a firm pull. If it is not locked in, back off on the locking knob and re-tighten.

To remove the plug-in, follow the same procedure as above. Make sure that either a blank panel or another interchangeable plug-in is re-installed in the counter.

CHAPTER 3
OPERATION

3.1 FUNCTIONAL OPERATION

The SD 1979H 350 MHz Prescaler plug-in extends the digital frequency measuring capability of the SD Models 1017, 1018, 1037 and 1038 counters by scaling the input frequency by a factor of 8 and dividing the counter time base by the same factor. In this manner the input signal frequency is brought within the measuring range of the counter yet the counter will (because of the time base extension) display the actual input frequency. Figure 3-1 illustrates the relationship of the SD 1979H to its parent counter. The plug-in will accept input signals in the range of 0 to 350 MHz at levels of 100 mV to 2 V rms for prescaling and display on the parent counter.

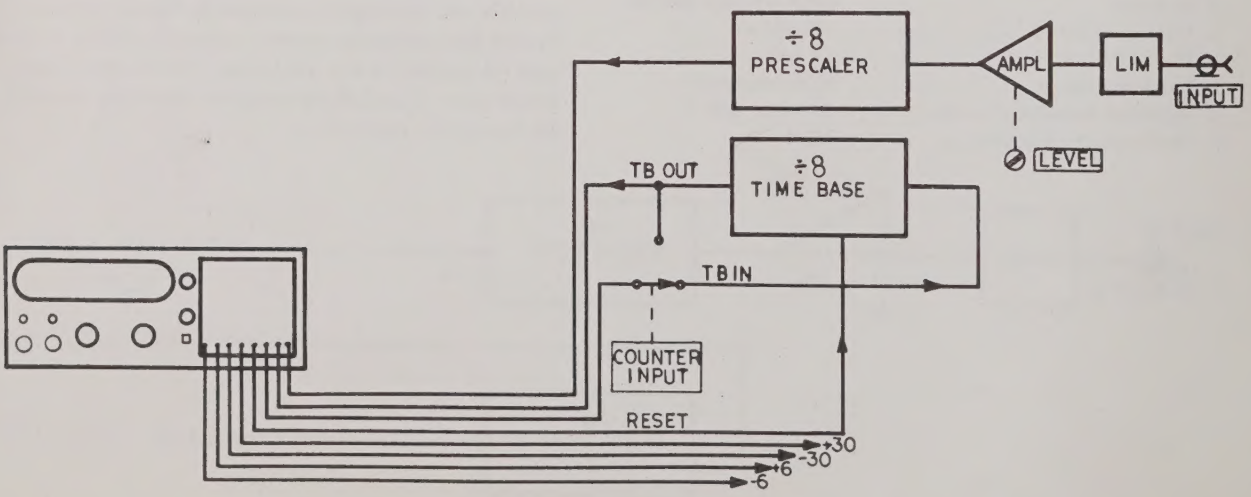

Figure 3-1 Relationship of the SD 1979H to its Parent Counter

3.2 PREPARATION FOR USE

a. Installation of plug-in:
   1) Make sure counter POWER switch is OFF.
   2) Remove the plug-in or blank panel installed in the counter by turning the locking knob located at the left of the plug-in receptacle at least two turns counter-clockwise. Pull the plug-in out by its handle. Generally a firm pull is required to unseat the connector.
   3) Check to see that the printed-circuit boards in the 1979H are firmly seated, then insert the plug-in into the receptacle, pushing it until it is flush with the counter's front panel. A firm push is usually necessary to properly seat the connector at the rear of the plug-in.
   4) Lock the plug-in in place by turning the locking knob clockwise until tight. Check by giving the plug-in handle a firm pull. If it is not locked in, back off on the locking knob and re-tighten.
   5) To remove the plug-in, follow the same procedure as above. Make sure that either a blank panel or another interchangeable plug-in is installed in the counter. Operation of SD counter-timers without a blank or other plug-in installed will disrupt the flow of cooling air in the counter and may cause the malfunction.

3.3 DESCRIPTION OF CONTROLS

Only two front-panel controls are provided on the Model 1979H. They are:

a. COUNTER-INPUT switch, S1. This switch provides normal operation of the parent counter in the COUNTER position. In the INPUT position it enables the time base divider circuit providing division of the counter time base by a factor of 8.
b. LEVEL control, R1 (screwdriver adjustment). Adjusts the input sensitivity of the prescaler circuit.

3.4 SEQUENCE OF OPERATION

The sequence of operation of the SD 1979H consists of peforming initial test functions on both the counter and plug-in then connecting the plug-in INPUT to the unknown signal source and making the frequency measurement. The steps of procedure for this sequence are given in Table 3-1. Refer to Chapter 4 of this manual if a fault indication is present.

STEP	ACTION	INDICATION
1	**Test of Parent Counter**	
	a) Set COUNTER-INPUT switch on plug-in to COUNTER position.	
	b) Place counter FUNCTION switch in the TEST position.	
	c) Turn DISPLAY control fully counter-clockwise.	
	d) On counter rear-panel, set the INTERNAL-EXTERNAL switch to INTERNAL.	
	e) Turn the TIME BASE switch on the counter to the "10^{-1}" position.	
	f) Turn counter POWER switch ON.	1) ON lamp illuminates 2) Display indicates 10 MHz
2	**Test of 1979H Time Base Division Function**	
	a) Set COUNTER-INPUT switch on plug-in to INPUT position.	1) Display indicates 80 MHz
3	**Test of 1979H Prescale Function**	
	a) Set counter RANGE switch to HET position.	
	b) Set counter FUNCTION switch to RATE (1017, 1018) or RATE C (1037, 1038).	
	c) Connect coaxial cable provided with plug-in between INPUT jack on 1979H and 1 MHz OUTPUT jack on counter rear-panel.	1MHz @ 1VRMS
	d) If necessary, adjust counter LEVEL Control to obtain stable count.	1) Display indicates 1 MHz
	e) Disconnect cable from rear-panel jack. The 1979H is now ready for use.	
4	**Frequency Measurement**	
	a) Set counter RANGE switch to HET.	
	b) Set counter FUNCTION switch to RATE (1017, 1018) or RATE C (1037, 1038)	
	c) Set counter TIME BASE switch for desired resolution.	
	d) Set 1979H COUNTER-INPUT switch to the INPUT position.	
CAUTION:	**DO NOT PERMIT INPUT SIGNAL LEVELS TO EXCEED 2 V RMS (2.8 V Peak)**	
	e) Connect coaxial cable provided (SD 10338) to signal source under test.	
	f) If required, adjust 1979H LEVEL control to provide a stable count (See Paragraph 3-5).	1) Counter display indicates frequency of input signal

Table 3-1 Sequence of Operation

3.5 ADJUSTMENT OF LEVEL CONTROL

The front-panel level control on the 1979H is initially set at the factory to provide maximum sensitivity of triggering with a sinusoidal input signal. If this setting has been changed, the operator may readjust the LEVEL control following the procedure given in Table 3-2.

STEP	ACTION	INDICATION
1	Connect the 50Ω output from an HP 608C (or equivalent) signal generator to the INPUT jack of the plug-in.	
2	Set the output of the signal generator for a 100 mV signal at 200 MHz.	
3	Set the LEVEL control fully CCW.	
4	Adjust the LEVEL control CW until a stable count is obtained.	1) Counter displays stable 200 MHz count.
5	Alternately reduce the level of the input signal and readjust the LEVEL control CW for a stable count until the minimum input level is reached which will produce a stable count.	2) Counter displays stable 200 MHz count.
6	Disconnect the signal generator from the 1979H INPUT jack. The triggering sensitivity is now set to optimum for sinusoidal input signals.	

Table 3-2 Level Adjustment

When measuring negative-pulsed signals, set the LEVEL control fully CW, then turn CCW until stable triggering is achieved. For positive-pulsed signals, set the LEVEL control fully CCW. Then turn CW until stable triggering is achieved.

3.6 OPERATOR'S MAINTENANCE

No special operational or preventive maintenance procedures are required for the SD 1979H. When the instrument is not in use and outside the parent counter, it should be stored inside an appropriate container to prevent damage to exposed hardware and circuitry.

CHAPTER 4
TROUBLESHOOTING

4.1 OVERALL FUNCTIONAL DESCRIPTION

The functional block diagram of the SD 1979H is illustrated in Figure 4-1. The individual assemblies are constructed on printed circuit boards which may be removed for purposes of adjustment, troubleshooting and replacement of parts. The following are the functional sections of the 1979H Plug-in:

a. Prescaler Assembly, S23771. This assembly contains the circuits that limit, amplify and scale the input signal and provides this scaled signal at a level of 100 mV or greater to the HET input line of the parent counter.

b. Time Base Divider Assembly, S23718. This assembly contains the circuits that divide the selected counter time base by a factor of 8 and applies the resulting waveform to the counter gate start/stop channel thus extending the counter gating interval by an amount that will provide direct display of the input signal frequency.

c. Voltage Regulators (located on Assembly S23718). Three voltage regulator circuits are employed to provide +13 V, +4 V and -15 V for operation of the prescaler circuits.

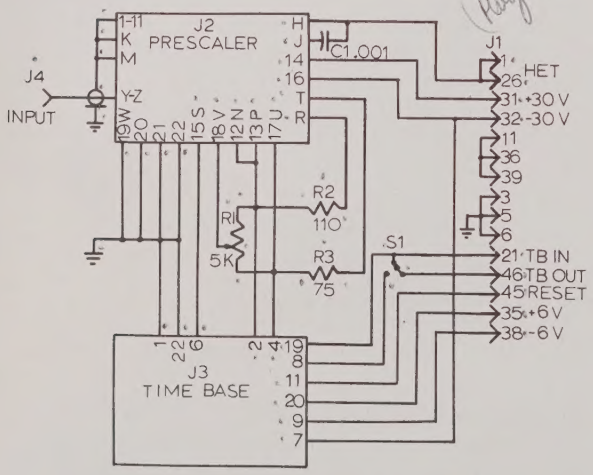

Figure 4-1 Functional Block Diagram
SD 1979H Prescaler Plug-in

4.2 OVERALL TROUBLESHOOTING

The SD 1979H is a rugged, all solid-state instrument and should provide long, trouble-free service. Apparent malfunction is sometimes due to the operator being unfamiliar with the instrument. It is wise to double check instrument connections and to review specifications to make sure operation is not being attempted beyond the capability of the instrument.

The most likely causes of actual malfunction are improper adjustment of the LEVEL control and burn-out of input amplifier componenets due to accidental overload from external circuitry. Input overload is usually characterized by failure of transistors Q1 and Q3 in the prescaler assembly. If overload is suspected, a check of these two transistors should be made first, followed by a check of their associated circuit components.

The general procedure to follow in the event of suspected malfunction of any kind is to first isolate the problem to either counter or the plug-in; then, if the problem is found to be in the plug-in, to isolate the malfunction to either the time base divider or prescaler assemblies. The chart given in Table 4-1 will be useful for overall symptom recognition and fault isolation.

Troubleshooting procedures for the individual functional sections are given in subsequent paragraphs of this chapter. The equipment required for troubleshooting is listed in Table 4-2.

STEP	ACTION	RESULTS	NEXT STEP
1	**Test of Parent Counter** a) Set COUNTER-INPUT switch on plug-in to COUNTER position. b) Place counter FUNCTION switch in the TEST position. c) Turn DISPLAY control fully CCW. d) On counter rear-panel, set the INTERNAL-EXTERNAL switch to INTERNAL. e) Turn the TIME BASE switch on the counter to the "10^{-1}" position. f) Turn the counter POWER switch ON.	1) Counter display indicates 10 MHz. 2) Fault indication.	3
2	Refer to appropriate counter manual for servicing instructions.		
3	**Test of 1979H Time Base Divider Function** a) Set COUNTER-INPUT switch on the plug-in to the INPUT position.	1) Display indicates 80 MHz. 2) Fault indication.	5 4
4	Refer to Table 4-3 and perform indicated steps of the troubleshooting procedure.		
5	**Test of 1979H Prescaling Function** a) Set counter FUNCTION switch to RATE (1017, 1018) or RATE C (1037, 1038). b) Set counter RANGE switch to the HET position. c) Set counter TIME BASE switch to the "10^{-1}" position. d) Set plug-in COUNTER-INPUT switch to INPUT position. e) Connect the 50Ω-output of a HP608C (or equivalent) signal generator to the the INPUT jack of the plug-in and set the output of the signal generator for a 100 mV signal at 200 MHz. f) Starting from the fully CCW position, adjust the LEVEL control CW until a stable count is obtained.	1) Counter displays stable 200 MHz count. 2) Counter displays erratic or no count.	7 6
6	Refer to Table 4-5 and perform the indicated steps of the troubleshooting procedure.		
7	Plug-in overall functional operation is apparently normal. Review symptoms. If a malfunction at a particular frequency or over a band of frequencies is the case, again refer to Table 4-5 for troubleshooting procedure.		

Table 4-1 Overall Troubleshooting Procedure

TYPE	MODEL	REQUIREMENT
Electronic Counter	SD 1017, 1018, 1037 or 1038	Provide operating voltages and display for 1979H.
Volt-ohm-milliameter	Simpson 269 or equivalent.	Voltage and resistance measurement, 3% accuracy.
Oscilloscope	Tektronix Model 581 with type 82 plug-in, or equivalent.	Waveform observation and measuring; 100 mV/cm sensitivity, to 30 MHz.
Oscilloscope, sampling	Tektronix 561A with sampling plug-ins, or equivalent.	Waveform observation and measuring; 100 mV/cm sensitivity, to 350 MHz.
Signal Generator	Hewlett-Packard Model 608C (or equivalent).	Signal source for testing; 0-200 mV, 10-350 MHz, 50Ω.
Plug-in extender cable	SD 17245	Operation of plug-in outside of counter.

Table 4-2 Equipment Required for Troubleshooting

4.3 TIME BASE DIVIDER ASSEMBLY, S23718

Reference drawings for this assembly are Figure 4-2, Servicing Block Diagram; Figure 5-1. Time Base ÷ 8 PC Assembly (S23718); and Figure 5-2, Time Base ÷ 8 Schematic Diagram (S23719).

Refer to Figure 4-2. The selected time base signal from the counter is inverted by Q5 to provide the trigger for the first stage of a three-stage scale-of-8 binary circuit, IC1 and IC2. IC1 and IC2 are dual J-K integrated-circuit flip-flops having nominal logic levels of OV and +3.5V.

The scale-of-8 binary is initially reset to binary "7" by a trigger from the NPN reset line of the counter through the inverter, Q6. This insures that the initial positive step of the time base input at J3-19 results in an immediate positive step at the time base output, J3-8, that will start the counter gate. After eight input time base cycles, the time base output will again go positive and stop the counter gate. The overall result is to produce a counting interval that is eight times the selected time base permitting direct readout of the input signal frequency to the 1979H on the counter display.

CR3 and R11 provide the regulated +5.0V required to operate the J-K flip-flops and input inverter circuits. The +4.0V, +13V and -15V regulator circuits are also located on this assembly but since they are used to operate the prescaler, their operation is discussed in Paragraph 4.4.

Troubleshooting this assembly consists of measuring the DC operating voltages, then checking the divider waveforms until the fault is isolated to a particular circuit. Voltage and resistance checks will then usually isolate the fault to a particular component or components. Table 4-3 gives the steps of procedure for troubleshooting this assembly. Table 4-4 indicates the nominal transistor terminal voltages to ground.

STEP	ACTION	RESULTS	NEXT STEP
1	Set counter and plug-in controls as in Step 3 of Table 4-1.	1) Counter display zero. 2) Counter display erratic.	2 9
2	Check DC operating voltages: a) Measure +6.0 V line at J3-20. b) Measure -6.0 V line at J3-9.	1) Reading normal. 2) Reading abnormal.	4 3
3	Check wiring between assembly and counter.		
4	Measure regulated voltage across CR3 (5.1 V ±5%).	1) Reading normal. 2) Out of tolerance.	6 5
5	Check CR3, R11 and C7.		
6	Check time base divider waveforms: a) Set up oscilloscope for 5 V/cm sensitivity and 1 μs/cm sweep speed. b) Set counter TIME BASE switch to "10^{-6}" position and counter FUNCTION switch to the TEST position. c) Observe waveform at J3-8 and compare to that shown on Figure 4-2.	1) Waveform normal. 2) Waveform abnormal or absent.	8 7
7	Check waveforms at pin 13, IC2; pin 8, IC1; Q5 collector; and input at J3-19 and compare to Figure 4-2. Check circuit immediately past point where normal indication is first observed for defective components.		
8	Check connections between plug-in and counter. Time base divider circuit is apparently operating normally.		
9	Check reset pulse at collector of Q5.	1) Normal. 2) Abnormal or absent.	2 10
10	Check reset pulse input at J3-11 and Q6 inverter circuit.		

Table 4-3 Time Base Divider Troubleshooting Procedure

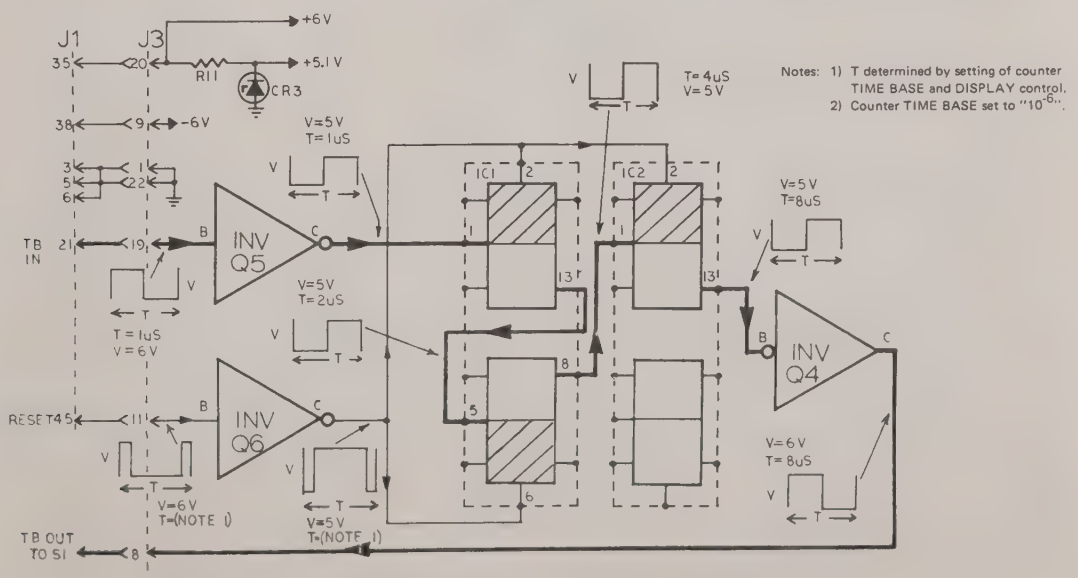

Figure 4-2 Servicing Block Diagram – Time Base Divider

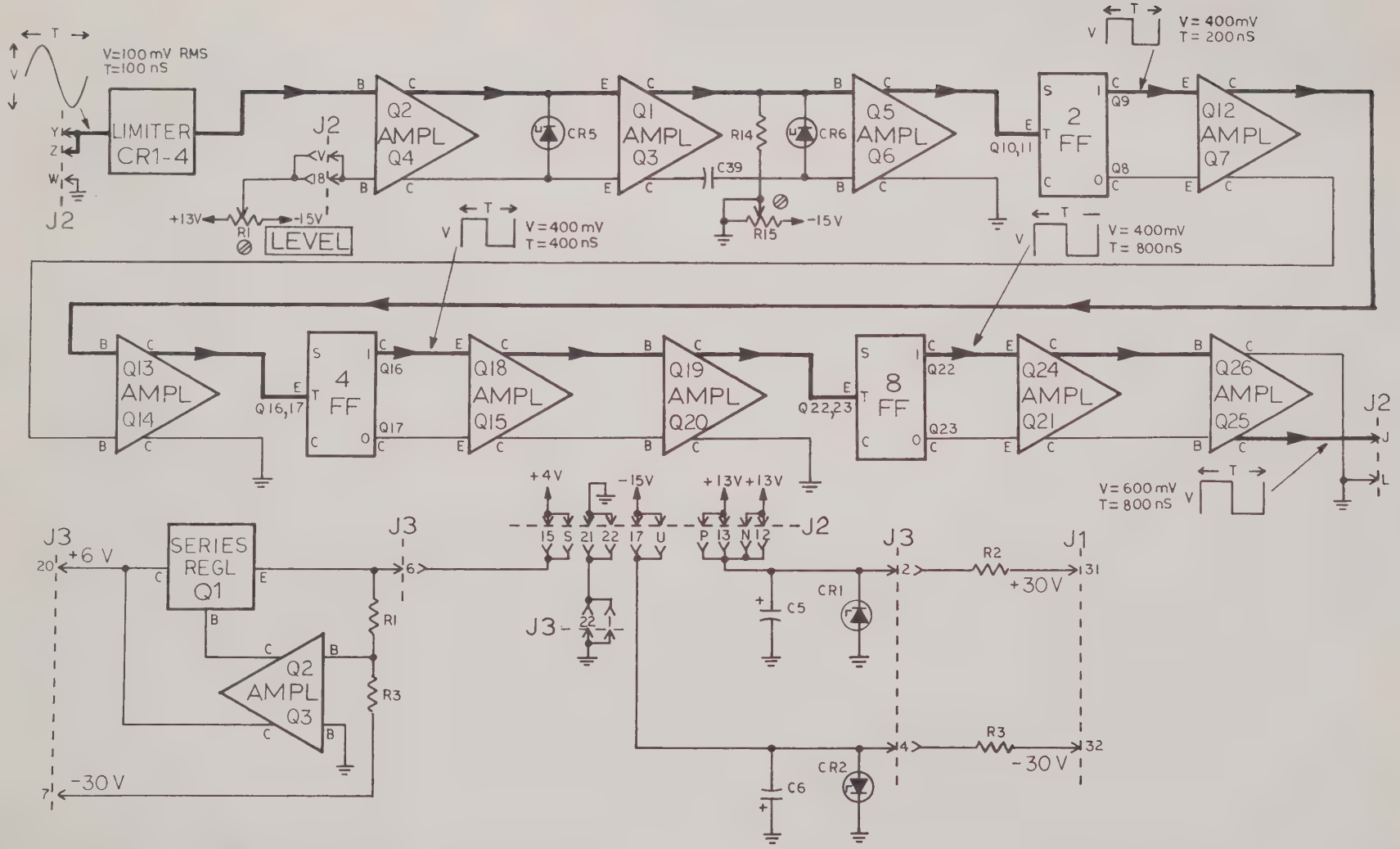

Figure 4-3 Servicing Block Diagram – Prescaler Assembly

TRANSISTOR	EMITTER	BASE	COLLECTOR	REMARKS
Q1	+4 V	+4.7 V	+6 V	Set INTERNAL-EXTERNAL switch on counter rear-panel to EXTERNAL.
Q2	-0.7	0	+4.7	
Q3	-0.7	0	+6	
Q4	0	+2	-6	
Q5	0	-1.3	+5	
Q6	0	-3	+5	

Table 4-4 Transistor DC Voltage Levels
Time Base Divider PC Board Assembly

4.4 PRESCALER ASSEMBLY, S23770

Reference drawings are Figure 4-3, Servicing Block Diagram; Figure 5-3, Prescaler Assembly (S23770; and Figure 5-4, Prescaler Schematic Diagram (S23771). Refer to Figure 4-3. The functional sections of this assembly are: the input limiter; the amplifier-shaper; the "2" binary; the "4" binary; and the "8" binary. The balanced amplifier arrangement used throughout this assembly ensures maximum stability of high-frequency performance and the tunnel diodes utilized in the amplifier-shaper permit the high-speed switching required.

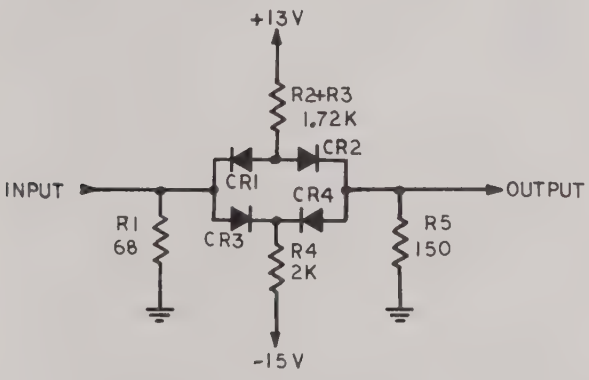

Figure 4-4 Input Limiter

a. **INPUT LIMITER.** A simplified schematic diagram of the input limiter circuit is shown in Figure 4-4. The circuit functions as a balanced bridge with the voltage across R5 following the input across R1 up to the limiting level.

The positive and negative limiting levels are set by the supply voltages and the size of the series resistors. For the values indicated, the output is limited to ±1V. When positive limiting occurs, CR2 and CR3 conduct; CR1 and CR4 block. When negative limiting occurs, CR1 and CR4 conduct; CR2 and CR3 block. The output of the limiter is applied to the first stage of the amplifier-shaper.

b. **AMPLIFIER-SHAPER.** Refer to the simplified schematic diagram of Figure 4-5. The amplifier-shaper circuits are essentially balanced differential amplifiers with tunnel diodes connected across their outputs to obtain the necessary switching speed.

R9 and the -15 V source form a constant current generator of approximately 15 mA to drive the emitters of Q2 and Q4. The current division between these two transistors is proportional to the difference of the input voltages applied to their bases and therefore the current level at the collector of Q2 may be varied by the level control, R1, and by the input signal across R5. A further simplification of the first stage of the amplifier-shaper is illustrated in Figure 4-6A.

Note that the forward current flow through the tunnel diode is set by the conduction of Q2, Q4, and a static level through R6. The operating point is determined by the net value of this current and the effective load for the tunnel diode, R7. See Figure 4-6B, point A. The input signal voltage required to switch the tunnel diode is that value which will increase the conduction of Q2 to a point where the peak current of the diode is exceeded. This change in current required is set statically by the LEVEL control and determines the sensitivity of the prescaler.

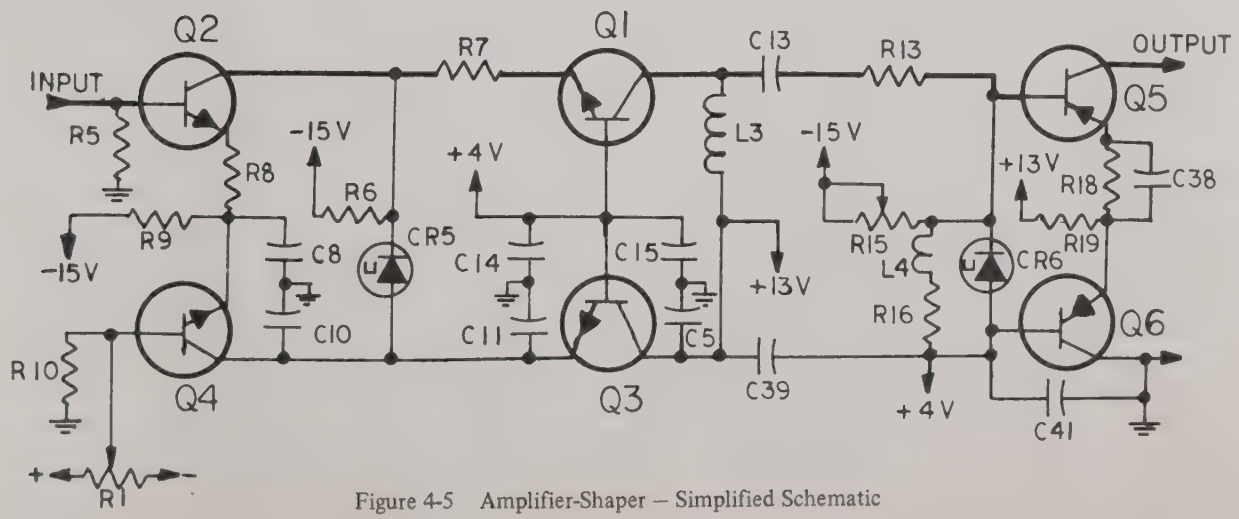

Figure 4-5 Amplifier-Shaper — Simplified Schematic

When the tunnel diode current reaches the peak point, it switches very rapidly to point B and will remain at this high voltage level until the input signal causes the tunnel diode current to fall below the valley point. The change in current in the tunnel diode between point and point B becomes a differential input to the common-base amplifier, Q1 and Q3.

The output of the common-base stage is switched by CR6 in a similiar manner. R15 sets the operating point for this diode. See Chapter 5 for the adjustment procedure. Adjusting the LEVEL control so that the tunnel diode, CR5, is statically operated at point B permits triggering by negative pulsed-signals.

R8 provides emitter degeneration to trade gain for bandwidth in the common emitter circuit of Q2. R18 and C38 serve this same purpose in the circuit of Q5. This is not required in the circuits of Q4 and Q6 since signal currents are bypassed around these transistors.

c. **"2" BINARY CIRCUIT.** Each of the binary circuits used in the prescaler consists of three elements: input amplifier, flip-flop, and output amplifier. All flip-flops are operated in the current mode (non-saturated condition) to achieve the required switching speed. The schematic for the first binary is re-drawn in Figure 4-7.

Q5 and Q6 function as the input amplifier. Q10 is the "O" side and Q11 the "1" side of the flip-flop. Q8 and Q9 are common-base amplifiers replacing the usual RC cross-coupling elements of the conventional flip-flop. L13 and L14 are ferrite beads which prevent the feedback loops from regenerating. Q7 and Q12 function as the output amplifier.

Current mode operation is achieved by the constant current sources (12 mA), R25, R24 and the +13 V supply. If Q11 is ON, it is conducting 10 mA while Q8 is conducting 2 mA; Q9 is conducting 12 mA and Q10 is OFF. When a positive pulse is applied from Q5, Q11 is cut OFF; Q8 conducts 12 mA, and turns Q10 ON. Q10 conducts 10 mA and Q9 drops to 2 mA keeping Q11 cut OFF until the next positive pulse.

The "4" and the "8" binary circuits are essentially the same except that, because of the reduced switching speed requirements, zener diodes are utilized as the cross-coupling elements.

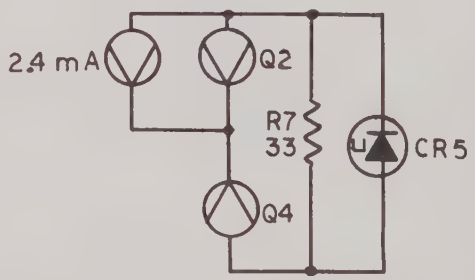

Figure 4-6A Equivalent circuit – Amplifier Shaper 1st Stage

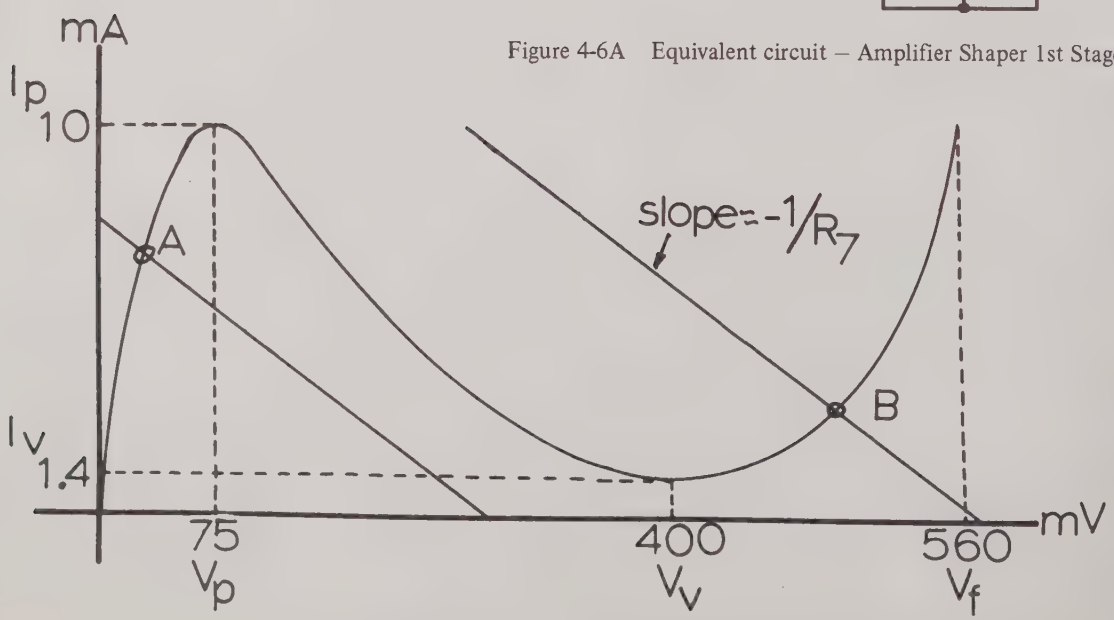

Figure 4-6B V-I Characteristic, CR5

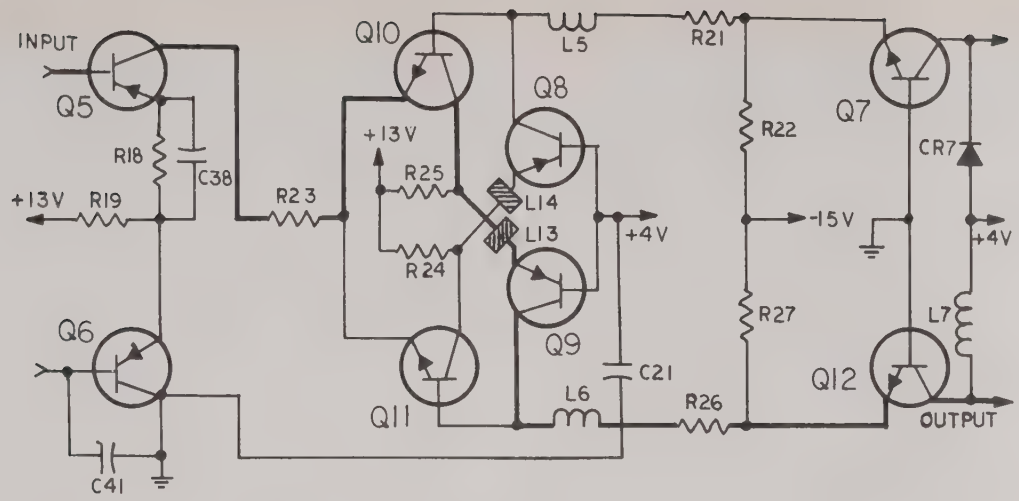

Figure 4-7 First Binary Circuit – Prescaler Assembly

The output from the prescaler is taken from the collector of Q25 and capacitor coupled through the rear panel plug to the HET input line of the parent counter. With a 100 mV signal input, the nominal output to the counter is 600 mV peak-to-peak.

d. **VOLTAGE REGULATOR CIRCUITS.** (See Figure 5-2, Schematic Diagram for Time Base Divider). Three regulator circuits are used to provide the operating voltages for the Prescaler assembly. These are located on the Time Base Divider PC Board. CR1 and CR2 are zener diode shunt regulators that provide +13 V and -15 V from the parent counter's +30 and -30 volt supply.

A regulated +4 V is obtained from the series regulator circuit of Q1, Q2, and Q3. In this circuit, the voltage divider (R1, R3, R16) samples the output voltage and applies the sampled voltage to the base of Q2. Q2 and Q3 form a differential amplifier circuit which compares the sampled voltage on the base of Q2 to a reference voltage (ground potential) on the base of Q3 and produces an output current at the collector of Q2 that is proportional to their difference. The net current to the base of the series regulator transistor, Q1, is the difference between the collector current of Q2 and the current supplied from the +6 volt source through R2. Thus, a drop in the output voltage of the regulator will result in a decrease in Q2 collector current and an increase in Q1 base current. This reduces the dc voltage drop across Q1 thereby increasing the output voltage. The degree of regulation obtained is controlled by the gain of Q2.

Troubleshooting of the Prescaler consists of measuring the DC operating voltages, then isolating the malfunction by checking circuit waveforms. **CAUTION: TROUBLESHOOTING AND REPAIR OF THIS ASSEMBLY SHOULD BE ATTEMPTED ONLY BY PERSONS WHO ARE THOROUGHLY FAMILIAR WITH VHF-UHF CIRCUITS AND TECHNIQUES.** Table 4-5 gives the steps of procedure for troubleshooting this assembly.

STEP	ACTION	RESULTS	NEXT STEP
1	Measure following input DC voltages: a) +30 V at J3-2. b) -30 V at J3-4. c) +6 V at J3-20.		
		1) Readings normal.	3
		2) Readings abnormal.	2
2	Check wiring between assembly and counter.		
3	Check regulated +4 volts at J2-15, S.	1) Reading normal.	5
		2) Reading abnormal.	4
4	Refer to Table 4-4 and check voltages on transistors Q1, Q2 and Q3 located on time base divider PC board. Replace defective components.		
5	Measure +13 V at J2-P, 13 and J2-N, 12; Measure -15 V at J2-17, U.	1) Reading normal.	7
		2) Reading abnormal.	6
6	Check CR1, CR2, C5 and C6 on time base divider PC board and R2 and R3 on chassis of 1979H.		
7	Check operation of prescaler assembly: a) Connect 50 Ω output of a HP608C signal generator to the INPUT of prescaler. Adjust signal generator for 100 mV output at 10 MHz. b) Place COUNTER-INPUT on 1979H to the INPUT position. c) Set parent counter RANGE switch to HET, FUNCTION switch to RATE (1017, 1018) or RATE C (1037, 1038), TIME BASE switch to "10^{-3}". Adjust LEVEL control as necessary.	1) Stable 10 MHz display on counter.	
		2) Display zero or erratic.	8
8	Set up Tektronix 581 oscilloscope for 0.1 μs/cm sweep speed and 0.1 V/cm sensitivity and observe waveform at the collector of Q9 (Base of Q11). Compare to that shown on Figure 4-3, Servicing Block Diagram.	1) Waveform normal.	
		2) Waveform abnormal.	9
9	Isolate defective component(s) by refering to Table 4-6 and checking DC voltages in Amplifier-Shaper and 1st Binary circuits. Refer to Chapter 5 for parts location and replacement procedures.		7
10	Check the waveform at the junction of L9 and R38 (See Figure 5-3) and compare to that shown on servicing block diagram, Figure 4-3.	1) Waveform normal.	12
		2) Waveform abnormal.	11
11	Isolate defective component(s) by refering to Table 4-6 and checking DC voltages in 2nd Binary circuit. Refer to Chapter 5 for parts location and replacement procedures.		7
12	Check the waveform at the junction of L12 and R49 (See Figure 5-3) and compare to that shown on servicing block diagram, Figure 4-3.	1) Waveform normal.	14
		2) Waveform abnormal.	13

STEP	ACTION	RESULTS	NEXT STEP
13	Isolate defective components by refering to Table 4-6 and checking DC voltages in 3rd Binary circuit. Refer to Chapter 5 for parts location and replacement procedures.		7
14	Check the waveform at the collector of Q25. Compare to that shown on the servicing block diagram.	1) Waveform normal. 2) Waveform abnormal.	16 15
15	Isolate defective components by refering to Table 4-6 and checking DC voltages in output amplifier circuit.		7
16	Check wiring between plug-in and counter.		7
17	Increase signal generator frequency to 100 MHz and adjust output for 100 mV. Adjust plug-in LEVEL control to obtain stable count.	1) Stable count on counter display. 2) Zero or erratic count.	21 20
18	Isolate malfunction by checking waveforms shown in Figure 4-8 with a sampling oscilloscope. Replace defective components.		17
19	Increase the frequency of the signal generator to 350 MHz and adjust output to 100 mV. Adjust plug-in LEVEL control for a stable count.	1) Stable count on counter display. 2) Zero or erratic count.	21 20
20	Isolate defective components by refering to Table 4-6 and checking DC voltages in Output Amplifier circuit. Refer to Chapter 5 for parts location and replacement procedures.		19
21	Check sensitivity of 1979H from 10 Hz to 360 MHz. Sensitivity should be less than 100 mV rms.	1) Overall poor sensitivity.	22
22	Check CR5 and Q2. These components set the overall sensitivity of the instrument.		

Table 4-5 Troubleshooting Procedure – Prescaler Assembly

TRANSISTOR	EMITTER	BASE	COLLECTOR	REMARKS
Q1	+3.3	+4.0	+13.0	LEVEL control set
Q2	−0.7	0.0	+ 3.2	for zero volts on
Q3	+3.3	+4.0	+13.0	base of Q4.
Q4	−0.7	0.0	+ 3.3	No signal input.
Q5	+3.6	+3.9	− 1.7	
Q6	+3.7	+4.0	0.0	
Q7	−0.7	0.0	+ 3.3	
Q8	+4.7	+4.0	− 0.6	
Q9	+4.7	+4.0	− 0.3	
Q10	−1.0	−0.6	+ 4.7	
Q11	−1.0	−0.3	+ 4.7	
Q12	−0.7	0.0	+ 4.0	
Q13	+4.2	+4.0	− 1.5	
Q14	+4.4	+4.0	0.0	
Q15	−0.7	0.0	+ 3.3	
Q16	−0.9	−0.6	+ 4.0	
Q17	−0.9	−0.2	+ 3.6	
Q18	−0.7	0.0	+ 4.0	
Q19	+4.2	+4.0	− 1.5	
Q20	+4.3	+4.0	0.0	
Q21	−0.7	0.0	+ 4.0	
Q22	−0.9	−0.6	+ 4.0	
Q23	−0.9	−0.2	+ 3.6	
Q24	−0.7	0.0	+ 3.3	
Q25	+4.7	+4.0	− 2.0	
Q26	+4.7	+3.6	0.0	

Table 4-6 Transistor DC Voltage Levels to Ground
Prescaler Assembly

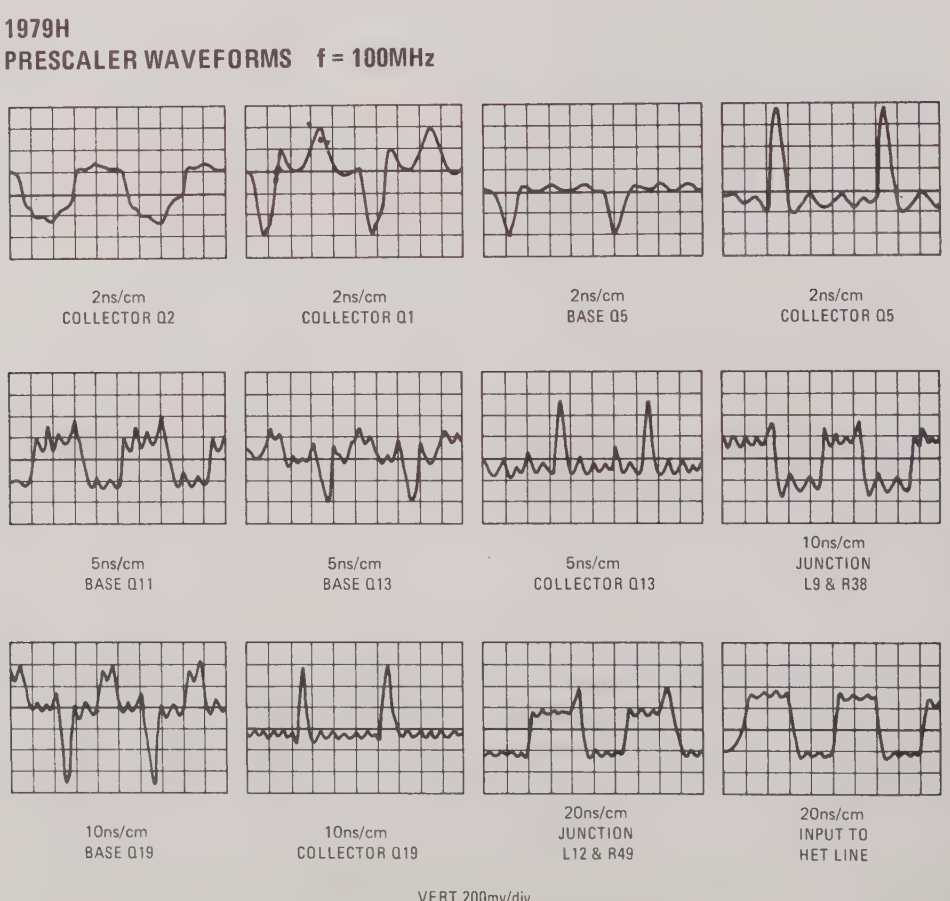

Figure 4-8 Prescaler Waveforms - 100MHz Input

CHAPTER 5
MAINTENANCE

5.1 FACTORY SERVICE

Whenever a Systron-Donner instrument requires service, the nearest SD representative should be contacted. He can provide field service or arrange factory returns when necessary. Address all inquiries on operation, maintenance or application to your nearest sales representative, or Sales-Manager, Systron-Donner Corporation, 888 Galindo Street, Concord, California 94520. Specify both model and complete serial number in all correspondence.

5.2 PREVENTIVE MAINTENANCE

No special preventive maintenance procedures are required for the SD 1979H. When not in use and outside the parent counter, the instrument should be stored inside an appropriate container to avoid accidental damage to exposed hardware and circuitry.

5.3 PARTS REPLACEMENT

a. General. To replace a part on a printed circuit board, cut the leads of the part near the lead holes. Using a low power soldering iron (50-watt or less), apply heat sparingly to the cut lead. As soon as the solder melts, slip the lead from the hole and clean the hole with a toothpick. Clean the board with isoprophyl alcohol. Form the tinned leads of the replacement part and insert in the cleaned holes, trimming leads to extend 1/16-inch beyond the back surface of the board. Use only 63-37 solder with a maximum diameter of 1/16-inch. Solder the leads to the board and use a hemostat, long-nose pliers or other heat sink on the leads of all semiconductor devices and resistors of 1/4-watt rating or less. Allow the soldered junction to cool before removing the heat sink.

b. Prescaler Assembly PC Board. Persons responsible for the maintenance and repair of this instrument should insure that only exact replacements are used and that parts replaced conform exactly to the original orientation and lead length. Tunnel diodes CR5 and CR6 must be selected for a peak current range of 9.2 to 9.9 mA; zener diodes CR10, CR12 and CR13,14 must be matched ±50 mV at 10 mA. A test circuit for measuring the peak current of tunnel diodes is illustrated in Figure 5-5. With the potentiometer R1 initially set for maximum resistance, resistance is decreased until the voltage indicated on the voltmeter takes a sharp jump – from about 75 mV to about 560 mV for the type TD 253. The current indicated on M1 at the point of switching is the peak current point of the diode's characteristic.

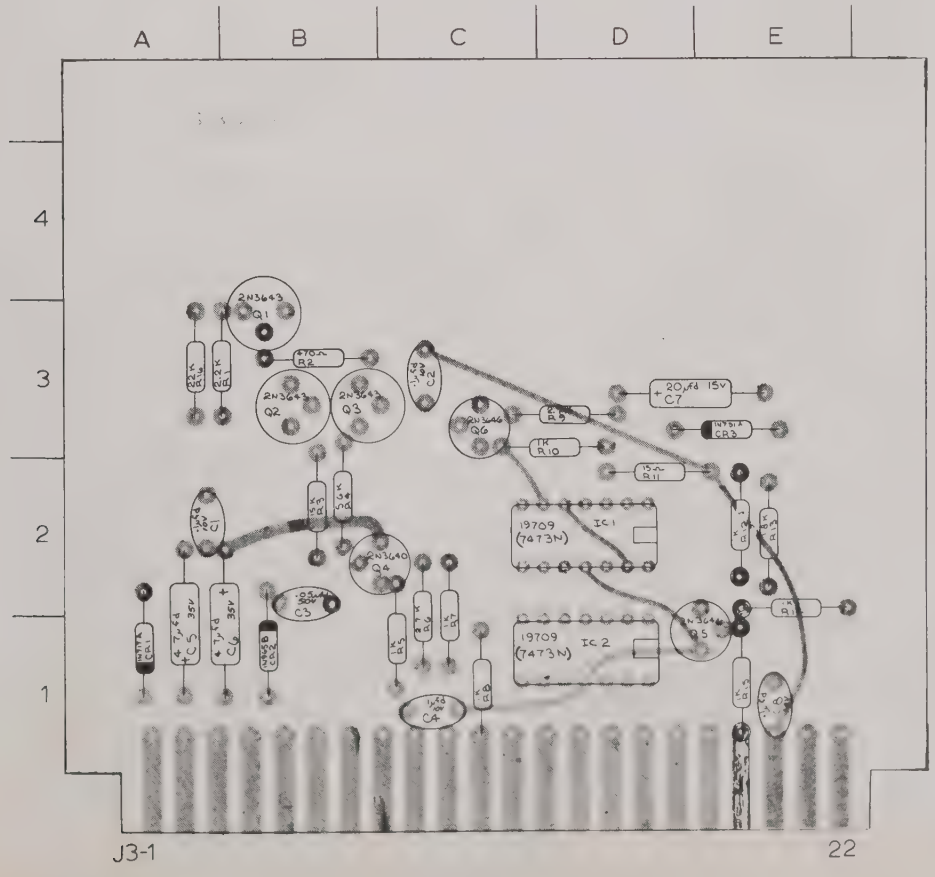

Figure 5-1 Time Base PC Ass'y, S23718

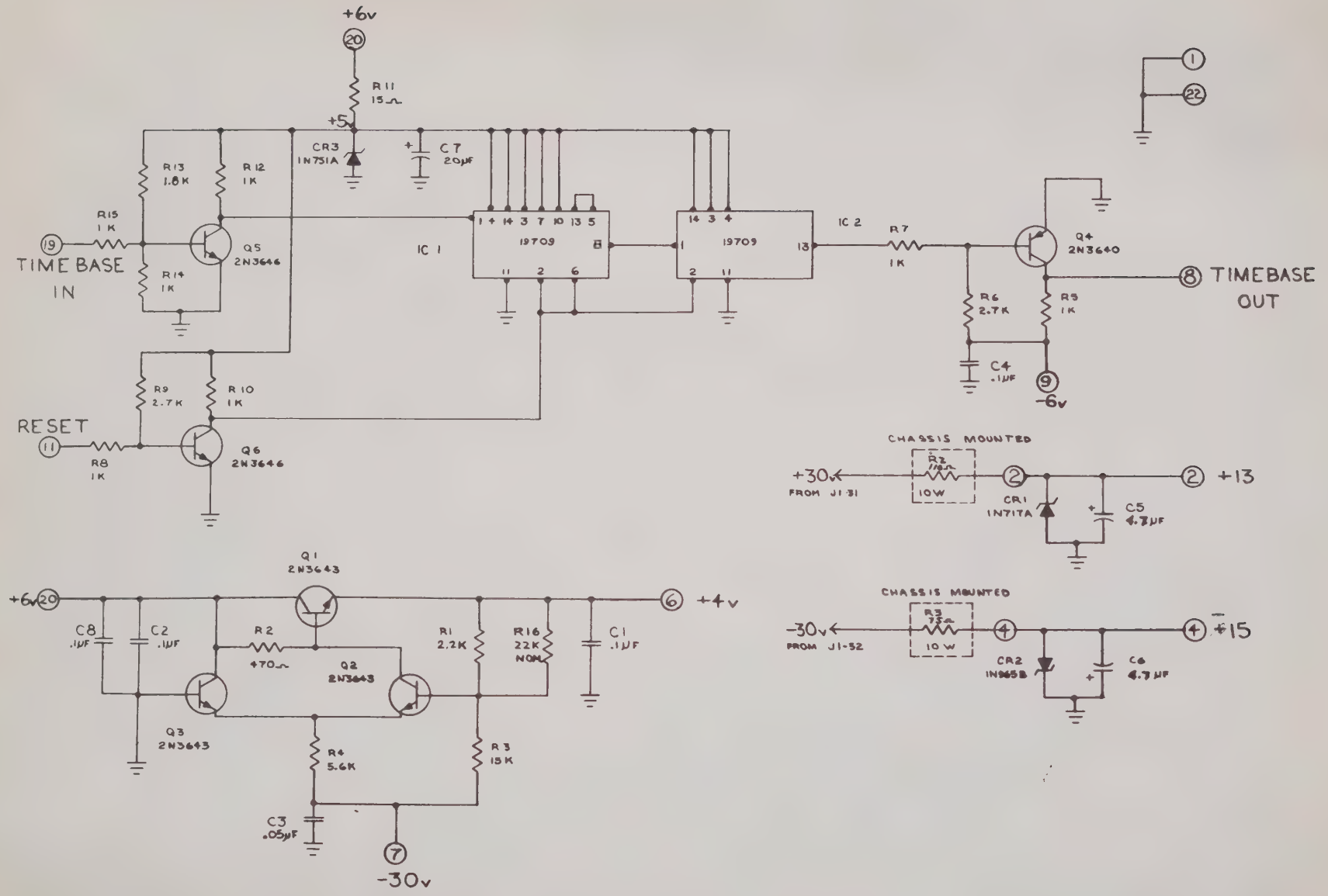

Figure 5-2 Schematic Diagram Time Base Divider (S23719)

Inductors L5 and L6 on the prescaler board are resistor leads with the dimensions shown in Figure 5-6A. L8, L9, L11 and L12 are formed with lengths of AWG 26 as shown in Figure 5-6B.

R17, R19, R29 and R41 are selected values unique to the particular characteristics of the components used in the prescaler circuits. Refer to Paragraph 5-4 for the selection procedure.

REF DESIG	ILLUS INDEX	SD PART NUMBER	REF DESIG	ILLUS INDEX	SD PART NUMBER
C1	A 2	C0661	R1	A 3	R0749
C2	C 3	C0661	R2	B 3	R1044
C3	B 2	C0708	R3	B 2	R0728
C4	C 1	C0661	R4	B 2	R0821
C5	A 1,2	C0878	R5	C 1,2	R0765
C6	A 1,2	C0878	R6	C 1,2	R0937
C7	DE 3	C0812	R7	C 1,2	R0765
C8	E 1	C0661	R8	C 1	R0765
CR1	A 1	CR0127	R9	D 3	R0937
CR2	A 1	CR0139	R10	CD 3	R0937
CR3	DE 3	CR0095	R11	D 2	R1607
IC1	CD 2	19709	R12	E 2	R0765
IC2	CD 1	19709	R13	E 2	R0959
Q1	B 3,4	Q0179	R14	E 1,2	R0765
Q2	B 3	Q0179	R15	E 1	R0765
Q3	BC 3	Q0179	R16	A 3	R0768
Q4	BC 2	Q0178			
Q5	DE 1,2	Q0218			
Q6	C 3	Q0218			

Table 5-1

Parts Location – Time Base ÷8 PC BD. Ass'y S23718

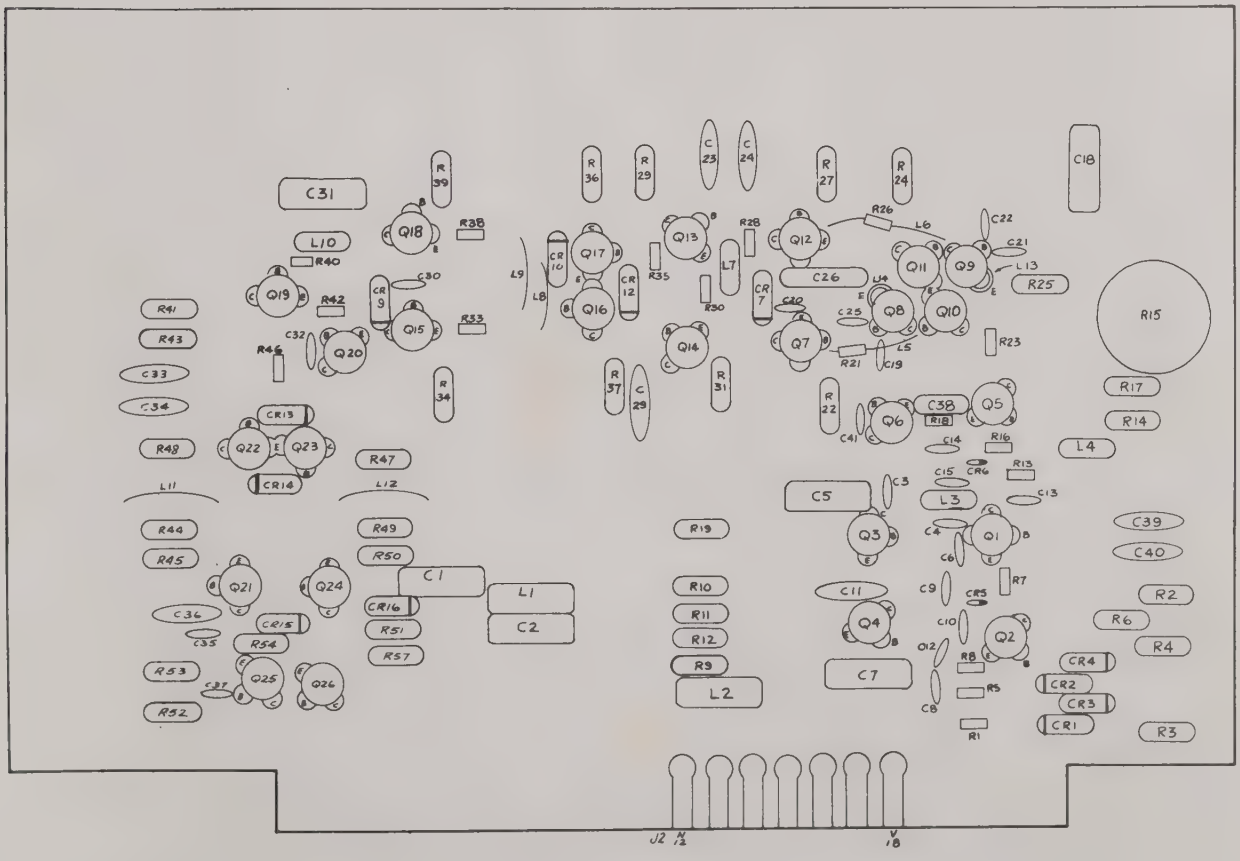

Figure 5-3 Prescaler Assembly, S23771

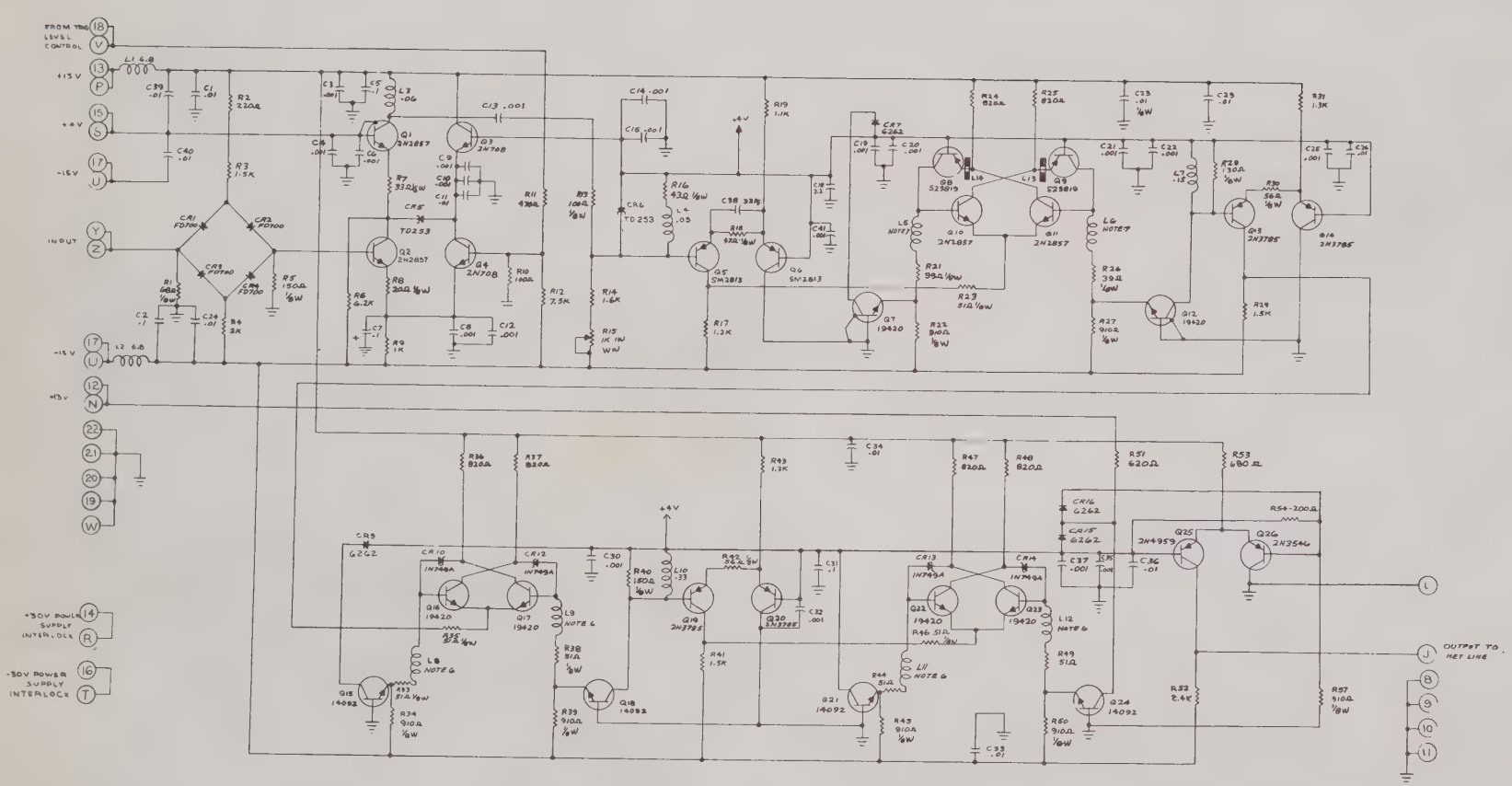

Figure 5-4 Prescaler Schematic, S23772

REF DESIG	ILLUS INDEX	SD PART NUMBER	REF DESIG	ILLUS INDEX	SD PART NUMBER
C1	BC 2	C0881	CR9	B 3	CR0150
C2	CD 1	C0881	CR10	C 3,4	CR0306
C3	E 2	Cxxxx *	CR11	Not used	–
C4	F 2	Cxxxx	CR12	D 3	CR0306
C5	E 2	C0881	CR13	B 3	CR0306
C6	F 2	Cxxxx	CR14	B 2	CR0306
C7	EF 1	C0524	CR15	B 1	CR0150
C8	F 1	Cxxxx	CR16	BC 1	CR0150
C9	F 2	Cxxxx	L1	CD 1,2	L0053
C10	F 1	Cxxxx	L2	DE 1	L0053
C11	E 1,2	C0562	L3	F 2	Lxxxx
C12	F 1	Cxxxx	L4	FG 2	Lxxxx
C13	F 2	Cxxxx	L5	EF 3	Lxxxx
C14	F 2,3	Cxxxx	L6	EF 4	Lxxxx
C15	F 2	Cxxxx	L7	DE 3,4	Lxxxx
C16	Not used	–	L8	C 3	Lxxxx
C17	Not used	–	L9	C 3,4	Lxxxx
C18	G 4	Cxxxx	L10	B 4	Lxxxx
C19	E 3	Cxxxx	L11	A 2	Lxxxx
C20	E 3	Cxxxx	L12	BC 2	Lxxxx
C21	F 4	Cxxxx	L13	F 3	H0654
C22	F 4	Cxxxx	L14	E 3	H0654
C23	D 4	C0562	Q1	F 2	Qxxxx
C24	E 4	C0562	Q2	F 1	Qxxxx
C25	E 3	Cxxxx	Q3	E 2	Q0194
C26	E 3	C0881	Q4	E 1	Q0194
C27	Not used	–	Q5	F 3	Qxxxx
C28	Not used	–	Q6	E 2,3	Qxxxx
C29	D 2,3	C0562	Q7	E 3	19420
C30	BC 3	Cxxxx	Q8	EF 3	S23819
C31	B 4	C0879	Q9	F 4	S23819
C32	B 3	Cxxxx	Q10	F 3	Qxxxx
C33	A 3	C0562	Q11	F 3,4	Qxxxx
C34	A 3	C0562	Q12	E 3,4	19420
C35	A 1	Cxxxx	Q13	D 4	Qxxxx
C36	A 1	C0562	Q14	D 3	Qxxxx
C37	A 1	Cxxxx	Q15	BC 3	14092
C38	F 3	Cxxxx	Q16	D 3	19420
C39	G 2	C0562	Q17	D 3,4	19420
C40	G 2	C0562	Q18	BC 4	14092
C41	E 2,3	Cxxxx	Q19	B 3	Qxxxx
CR1	FG 1	CRxxx	Q20	B 3	Qxxxx
CR2	FG 1	CRxxx	Q21	AB 2	14092
CR3	FG 1	CRxxx	Q22	B 2	19420
CR4	FG 1	CRxxx	Q23	B 2	19420
CR5	F 1,2	S25287	Q24	B 2	14092
CR6	F 2	S25287	Q25	B 1	Qxxxx
CR7	E 3	CR0150	Q26	B 1	Q0192
CR8	Not used	–	R1	F 1	R1440
R2	G 2	R0760	R29	D 4	R0783
R3	G 1	R0783	R30	D 3	R1833
R4	G 1	R0734	R31	D 3	R0737
R5	F 1	R1442	R32	Not used	–
R6	G 1	R0965	R33	C 3	R1832
R7	F 2	R1827	R34	C 3	Rxxxx
R8	F 1	R1823	R35	D 3,4	R1832
R9	D 1	R0765	R36	D 4	R0762
R10	D 2	R0966	R37	D 3	R0762
R11	D 1	R1044	R38	C 4	R1832
R12	D 1	R0884	R39	C 4	Rxxxx
R13	F 2	R1441	R40	B 4	R1442
R14	G 3	R0977	R41	A 3	R0783
R15	G 3	Rxxxx	R42	B 3	R1833
R16	F 2	R1830	R43	A 3	R0737
R17	G 3	Rxxxx	R44	A 2	R1246
R18	F 3	R1449	R45	A 2	Rxxxx
R19	D 2	R0838	R46	B 3	R1832
R20	Not used	–	R47	BC 2	R0762
R21	E 3	R1829	R48	A 2	R0762
R22	E 2,3	Rxxxx	R49	BC 2	R1246
R23	F 3	R1832	R50	BC 2	Rxxxx
R24	EF 4	R0762	R51	AB 1	R1334
R25	F 3	R0762	R52	A 1	R1045
R26	E 4	R1829	R53	A 1	R1234
R27	E 4	Rxxxx	R54	B 1	R0736
R28	E 4	Rxxxx	R55	Not used	–
			R56	Not used	–
			R57	BC 1	Rxxxx

Table 5-2 Parts Location – Prescaler PC BD. Ass'y S23771

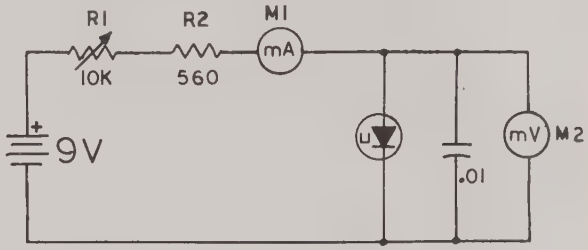

Figure 5-5 Tunnel Diode Test Circuit

Figure 5-6 Detail – Inductors L5, L6, L8, L9, L11, L12

5.4 CALIBRATION

a. Equipment Required
   1) DC differential voltmeter, Fluke 801 or equivalent
   2) Signal Generator, HP608C or equivalent
   3) Oscilloscope, Tektronix 581 with 82 plug-in or equivalent
   4) Oscilloscope, Sampling, Tektronix 561A with sampling plug-ins
   5) Electronic Counter, SD Model 1017, 1018, 1037 or 1038
   6) Plug-in extender cable, SD 17245
   7) Coaxial cable, SD10338

b. Preliminary Operations
   1) Inspect the plug-in for any visible defects. Take any necessary corrective action
   2) Verify that all power switches are OFF, and connect all applicable equipment to the power source

NOTE

The electronic counter should be continuously connected to

* SD Part Number not assigned. Order by Reference Designation and description shown in Table 6-1.

the power line. If not, allow sufficient time for the crystal oven to reach operating temperature prior to making measurements.

3) Set up the signal generator controls for minimum output and CW operation, then turn the POWER switch ON. Set up DVM to measure voltage in range of 0-30 volts.
4) Refer to the appropriate technical manual and set up the oscilloscope to measure 100 mV, 10 MHz signals.
5) Refer to the appropriate technical manual and set up the sampling oscilloscope to measure 100 mV, 100 MHz signals.
6) Install the SD 1979H in the parent counter.
7) Set the parent counter controls as follows:

FUNCTION switch to	TEST
DISPLAY control	CCW
INTERNAL-EXTERNAL switch to	INTERNAL
TIME BASE switch to	10^{-1}
RANGE switch to	HET
POWER switch to	ON

8) Allow 30 minutes warm-up for all instruments

c. Calibration Process

NOTE

Unless otherwise specified, verify the results of each test and take corrective action before proceeding.

1) Functional test, Time Base Divider
   a) Set COUNTER-INPUT switch on 1979H to INPUT position.
   b) Verify that counter display indicates 80 MHz
2) Functional test, Prescaler
   a) Set counter FUNCTION switch to RATE (1017, 1018) or RATE C (1037, 1038)
   b) Connect coaxial cable SD10338 between INPUT jack on 1979H and 1 MHz output jack on rear panel of parent counter.
   c) Verify that counter Display indicates 1 MHz
   d) Remove cable SD10338 from rear panel output jack
3) Check DC operating voltages
   a) Turn POWER switch on parent counter to OFF position
   b) Remove 1979H from counter
   c) Reconnect 1979H to parent counter using plug-in extender cable SD 17245.
   d) Set up DVM to 10 V full scale
   e) Connect DVM probe between junction of R11-CR3 and ground on Time Base Divider PC Board. (See Figure 5-1).
   f) Verify; that DC voltage present is 5.1 V ±5%
   g) Connect DVM probe between terminal J3-6 and ground on Time Base Divider PC Board. (See Figure 5-1)
   h) Verify that DC voltage present is 3.9 to 4.0 volts
   i) Set up DVM for 30 V full scale
   j) Connect DVM probe between terminal J3-2 and ground on Time Base Divider PC Board.
   k) Verify that DC voltage is +13 V ±5%
   l) Connect DVM probe between terminal J3-4 and ground on Time Base Divider PC Board
   m) Verify that DC voltage present is -15 V ±5%
4) Check Sensitivity at 10 MHz
   a) Set signal generator frequency to 10 MHz and output level to 100 mV
   b) Set R15 (trim-pot) on prescaler PC board to approximately mid-scale.
   c) Connect signal generator output to INPUT jack on 1979H and verify that plug-in LEVEL control can be adjusted to give a stable 10 MHz indication on the parent counter display.
5) Check sensitivity at 100 MHz
   a) Increase signal generator frequency to 100 MHz and adjust LEVEL control for a stable count.
   b) Verify that sensitivity is 100 mV or less.

NOTE

If sensitivity is poor, check with sampling scope the waveforms illustrated in Figure 4-8. If malfunction is traced to one of the three binary stages and defective components are replaced, it may be necessary to adjust the size of R17 (1st binary stage), R29 (2nd binary or R41 (3rd binary) to achieve stable triggering.

6) Check sensitivity at 350 MHz
   a) Increase signal generator frequency to 350 MHz and adjust LEVEL control for a stable count.
   b) Verify that sensitivity is 100 mV or less
7) Overload Tests
   a) Increase the frequency of the signal generator to 380 MHz
   b) Verify that the sensitivity is less than 200 mV
   c) Increase the output level of the signal generator to 1.0 V and verify that a stable count exists on the counter display down to 10 MHz

NOTE

Some overdrive areas are from 120 MHz to 190 MHz. If an overdrive spot is found, adjust R19 from 1.1 K to 1.2 K and recheck the overdrive areas. If overdrive is still present, readjust R19 and/or R17. A doubling effect may be noticed in the range of 40 to 65 MHz. If this is the case, a slight readjustment of R15 may be necessary and at the extreme, replacement of CR6.

8) Check overall sensitivity
   a) Return the signal generator level to 100 mV and check the overall sensitivity of the plug-in from 10 MHz to 360 MHz
   b) Verify that the sensitivity is 100 mV or less over this frequency range.

NOTE

If poor overall sensitivity is noted, check CR5 and Q2. These two components set the overall sensitivity of the SD 1979H.

10) Unless other measurements are to be performed, turn off and disconnect all equipment. If all tests were satisfactory, affix appropriate calibration label to front panel of SD 1979H.

CHAPTER 6
PARTS LIST

REF DESIG	NAME AND DESCRIPTION	SD PART NUMBER	REF FIG/DWG
MAIN FRAME – MODEL 1979H			
C1	Capacitor, .001 mF, pom 20%, 75 V	Cxxxx	S23722
J2	Connector, 22-pin, 2-row	J0248	S23722
J3	Connector, 22-pin, 1-row	J0341	S23722
J4	Connector, BNC	J0342	S23722
P1	Connector, 50-pin, male	J0261	S23722
R1	Potentiometer, 5KΩ, 1/2 W; 300AUGNAK-SD502A	Rxxxx	S23722
R2	Resistor, 110Ω, 10 W, 1%; Dale RH10	Rxxxx	S23722
R3	Resistor, 75Ω, 10 W, 1%; Dale RH10	Rxxxx	S23722
S1	Switch, SPDT	S0149	S23722
PRESCALER ASSEMBLY – S23771			
C1	Capacitor, 0.1mF, 20%, 50 V	C0881	S23772
C2	Same as C1	C0881	S23772
C3	Capacitor, 0.001mF, 20%, 75 V; Gulton MIN-M-001M	Cxxxx	S23772
C4	Same as C3	Cxxxx	S23772
C5	Same as C1	C0881	S23772
C6	Same as C3	Cxxxx	S23772
C7	Capacitor, 1 mF, 20%, 35 V	C0524	S23772
C8	Same as C3	Cxxxx	S23772
C9	Same as C3	Cxxxx	S23772
C10	Same as C3	Cxxxx	S23772
C11	Capacitor, 0.01mF, 20%, 50 V	C0562	S23772
C12	Same as C3	Cxxxx	S23772
C13	Same as C3	Cxxxx	S23772
C14	Same as C3	Cxxxx	S23772
C15	Same as C3	Cxxxx	S23772
C16	Not Used	–	
C17	Not Used	–	
C18	Capacitor, 2.2mF, 20%, 25 V; Sprague 5C15	Cxxxx	S23772
C19	Same as C3	Cxxxx	S23772
C20	Same as C3	Cxxxx	S23772
C21	Same as C3	Cxxxx	S23772
C22	Same as C3	Cxxxx	S23772
C23	Same as C11	C0562	S23772
C24	Same as C11	C0562	S23772
C25	Same as C3	Cxxxx	S23772
C26	Same as C1	C0881	S23772
C27	Not Used	–	
C28	Not Used	–	
C29	Same as C11	C0562	S23772
C30	Same as C3	Cxxxx	S23772
C31	Capacitor, 1mF, 20%, 25 V	C0879	S23772
C32	Same as C3	Cxxxx	S23772
C33	Same as C11	C0562	S23772
C34	Same as C11	C0562	S23772
C35	Same as C3	Cxxxx	S23772
C36	Same as C11	C0562	S23772
C37	Same as C3	Cxxxx	S23772
C38	Capacitor, 33pF; Elmenco DM-10-330-J	Cxxxx	S23772
C39	Same as C11	C0562	S23772
C40	Same as C11	C0562	S23772
C41	Same as C3	Cxxxx	S23772
CR1	Diode, silicon; Fairchild FD700	CRxxx	S23772
CR2	Same as CR1	CRxxx	S23772
CR3	Same as CR1	CRxxx	S23772
CR4	Same as CR1	CRxxx	S23772
CR5	Diode, tunnel; GE type TD 253 selected for 9.2 to 9.9 mA firing current		
CR6	Same as CR5	S25287	S23772
CR7	Diode, silicon; Type CD6262	CR0150	S23772
CR8	Not used	–	
CR9	Same as CR7	CR0150	S23772
CR10	Diode, zener; Type 1N749A, 4.2 V, 5%	CR0306	S23772
CR11	Not used	–	
CR12	Same as CR10	CR0306	S23772
CR13	Same as CR10	CR0306	S23772
CR14	Same as CR10	CR0306	S23772
CR15	Same as CR7	CR0150	S23772
CR16	Same as CR7	CR0150	S23772
L1	Inductor, 6.8 μH	L0053	S23772
L2	Same as L1	L0053	S23772
L3	Inductor, 0.06 μH, 10%; Jeffers Mfg. No. 10150-2	Lxxxx	S23772
L4	Inductor, 0.05 μH, 10%; Jeffers Mfg. No. 10150-4	Lxxxx	S23772
L5	Inductor, resistor lead; Part of R21	Lxxxx	S23772
L6	Inductor, resistor lead; Part of R26	Lxxxx	S23772
L7	Inductor, 0.15 μH, 10%; Jeffers Mfg. No. 4416-3K	Lxxxx	S23772
L8	Inductor, No. 26 AWG wire	Lxxxx	S23772
L9	Same as L8	Lxxxx	S23772
L10	Inductor, 0.33 μH, 10%, Jeffers Mfg. No. 4416-7K	Lxxxx	S23772
L11	Same as L8	Lxxxx	S23772
L12	Same as L8	Lxxxx	S23772
L13	Ferrite bead	H0654	S23772
L14	Same as L13	H0654	S23772
Q1	Transistor, NPN; type 2N2857	Qxxxx	S23772
Q2	Same as Q1	Qxxxx	S23772
Q3	Transistor, NPN; type 2N708	Q0194	S23772
Q4	Same as Q3	Q0194	S23772
Q5	Transistor, PNP; Motorola SM2813	Qxxxx	S23772
Q6	Same as Q5	Qxxxx	S23772
Q7	Transistor, NPN	19420	S23772
Q8	Transistor, PNP;TI type SG5201	S23819	S23772
Q9	Same as Q8	S23819	S23772
Q10	Same as Q1	Qxxxx	S23772
Q11	Same as Q1	Qxxxx	S23772
Q12	Same as Q7	19420	S23772
Q13	Transistor, PNP; Type 2N3785	Qxxxx	S23772
Q14	Same as Q13	Qxxxx	S23772
Q15	Transistor, NPN	14092	S23772
Q16	Same as Q7	19420	S23772
Q17	Same as Q7	19420	S23772
Q18	Same as Q15	14092	S23772
Q19	Same as Q13	Qxxxx	S23772
Q20	Same as Q13	Qxxxx	S23772
Q21	Same as Q15	14092	S23772
Q22	Same as Q7	19420	S23772
Q23	Same as Q7	19420	S23772
Q24	Same as Q15	14092	S23772
Q25	Transistor, PNP; Type 2N4959	Qxxxx	S23772
Q26	Transistor, PNP; 2N3546	Q0192	S23772
R1	Resistor, c.c.; 68Ω, 1/8 W, 5%	R1440	S23772
R2	Resistor, c.c.; 220Ω, 1/4 W, 5%	R0760	S23772
R3	Resistor, c.c.; 1.5 K, 1/4 W, 5%	R0783	S23772
R4	Resistor, c.c.; 2 K, 1/4 W, 5%	R0734	S23772
R5	Resistor, c.c.; 150Ω, 1/8 W, 5%	R1442	S23772
R6	Resistor, c.c.; 6.2 K, 1/4 W, 5%	R0965	S23772
R7	Resistor, c.c.; 33Ω, 1/8 W, 5%	R1827	S23772
R8	Resistor, c.c.; 20Ω, 1/8 W, 5%	R1823	S23772
R9	Resistor, c.c.; 1 K, 1/4 W, 5%	R0765	S23772
R10	Resistor, c.c.; 100Ω, 1/4 W, 5%	R0966	S23772
R11	Resistor, c.c.; 470Ω, 1/4 W, 5%	R1044	S23772
R12	Resistor, c.c.; 7.5 K, 1/4 W, 5%	R0884	S23772
R13	Resistor, c.c.; 100Ω, 1/8 W, 5%	R1441	S23772
R14	Resistor, c.c.; 1.6 K, 1/4 W, 5%	R0977	S23772
R15	Potentiometer; 1 K, 1W, IRC Type 100 WW	Rxxxx	S23772
R16	Resistor, c.c.; 43Ω, 1/8 W, 5%	R1830	S23772
R17	Resistor, metal glaze type C4; 1.2 K Nom	Rxxxx	S23772
R18	Resistor, c.c.; 47Ω, 1/8 W, 5%	R1449	S23772
R19	Resistor, c.c.; 1.1 K Nom, 1/4 W, 5%	R0838	S23772
R20	Not Used	–	
R21	Resistor, c.c.; 39Ω, 1/8 W, 5%	R1829	S23772
R22	Resistor, metal glaze type C4; 910Ω	Rxxxx	S23772
R23	Resistor, c.c.; 51Ω, 1/8 W, 5%	R1832	S23772
R24	Resistor, c.c.; 820Ω, 1/4 W, 5%	R0762	S23772
R25	Same as R24	R0762	S23772
R26	Same as R21	R1829	S23772
R27	Same as R22	Rxxxx	S23772
R28	Resistor, c.c.; 130Ω, 1/8 W, 5%	Rxxxx	S23772
R29	Same as R3	R0783	S23772
R30	Resistor, c.c.; 56Ω, 1/8 W, 5%	R1833	S23772
R31	Resistor, c.c.; 1.3 K, 1/4 W, 5%	R0737	S23772
R32	Not Used	–	
R33	Same as R23	R1832	S23772
R34	Same as R22	Rxxxx	S23772
R35	Same as R23	R1832	S23772
R36	Same as R24	R0762	S23772
R37	Same as R24	R0762	S23772
R38	Same as R23	R1832	S23772
R39	Same as R22	Rxxxx	S23772

Note: CR10-12 and CR13-14 matched-pairs.

REF DESIG	NAME AND DESCRIPTION	SD PART NUMBER	REF FIG/DWG
R40	Same as R5	R1442	S23772
R41	Same as R3	R0783	S23772
R42	Same as R30	R1833	S23772
R43	Same as R31	R0737	S23772
R44	Resistor, c.c.; 51Ω, 1/4 W, 5%	R1246	S23772
R45	Same as R22	Rxxxx	S23772
R46	Same as R23	R1832	S23772
R47	Same as R24	R0762	S23772
R48	Same as R24	R0762	S23772
R49	Same as R44	R1246	S23772
R50	Same as R22	Rxxxx	S23772
R51	Resistor, c.c.; 620Ω, 1/4 W, 5%	R1334	S23772
R52	Resistor, c.c.; 2.4 K, 1/4 W, 5%	R1045	S23772
R53	Resistor, c.c.; 680Ω, 1/4 W, 5%	R1234	S23772
R54	Resistor, c.c.; 200Ω, 1/4 W, 5%	R0736	S23772
R55	Not Used	–	
R56	Not Used	–	
R57	Same as R22	Rxxxx	S23772
TIME BASE –8 ASSEMBLY ÷ S23718			
C1	Capacitor, 0.1 mF, 10 V	C0661	S23719
C2	Same as C1	C0661	S23719
C3	Capacitor, 0.05mF, 50 V	C0708	S23719
C4	Same as C1	C0661	S23719
C5	Capacitor, 4.7mF, 35 V	C0878	S23719
C6	Same as C5	C0878	S23719
C7	Capacitor, 20mF, 15 V	C0812	S23719
C8	Same as C1	C0661	S23719

REF DESIG	NAME AND DESCRIPTION	SD PART NUMBER	REF FIG/DWG
CR1	Diode, zener; Type 1N717A, 13 V	CR0127	S23719
CR2	Diode, zener; Type 1N965B, 15 V	CR0139	S23719
CR3	Diode, zener; Type 1N751A, 5.1 V	CR0095	S23719
IC1	Integrated circuit; TI type 7473N	19709	S23719
IC2	Same as IC1	19709	S23719
Q1	Transistor, NPN; Type 2N3643	Q0179	S23719
Q2	Same as Q1	Q0179	S23719
Q3	Same as Q1	Q0179	S23719
Q4	Transistor, PNP; Type 2N3640	Q0178	S23719
Q5	Transistor, NPN; Type 2N3646	Q0218	S23719
Q6	Same as Q5	Q0218	S23719
R1	Resistor, c.c.; 2.2 K, 1/4 W, 5%	R0749	S23719
R2	Resistor, c.c.; 470Ω, 1/4 W, 5%	R1044	S23719
R3	Resistor, c.c.; 15 K, 1/4 W, 5%	R0728	S23719
R4	Resistor, c.c.; 5.6 K, 1/4 W, 5%	R0821	S23719
R5	Resistor, c.c.; 1 K, 1/4 W, 5%	R0765	S23719
R6	Resistor, c.c.; 2.7 K, 1/4 W, 5%	R0937	S23719
R7	Same as R5	R0765	S23719
R8	Same as R5	R0765	S23719
R9	Same as R6	R0937	S23719
R10	Same as R5	R0765	S23719
R11	Resistor, c.c.; 15Ω, 1/4 W, 5%	R1607	S23719
R12	Same as R5	R0765	S23719
R13	Resistor, c.c.; 1.8 K, 1/4 W, 5%	R0959	S23719
R14	Same as R5	R0765	S23719
R15	Same as R5	R0765	S23719
R16	Resistor, c.c.; 22 K, 1/4 W, 5%, Nom	R0768	S23719

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